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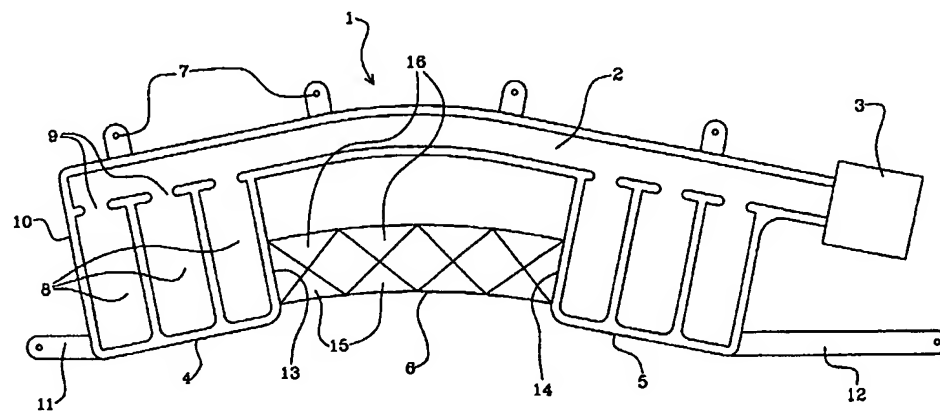
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**WO 2000/007854 A1 WO 1999/062746 A1**  
**US 5322322 A**

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(54) Abstract Title  
**Air bag with tensioning means**

(57) An air bag 1 is adapted to be mounted in a recess in a roof of a motor vehicle, such as at the side of the vehicle. The air bag comprises at least two inflatable regions 4,5 and a woven interconnecting element 6, an upper edge of the air bag having anchoring means 7. Upon inflation each inflatable region is located beneath the upper edge in a spaced apart manner, with an outer edge 10 of at least one said region having anchoring means 11. The woven interconnecting element comprises a plurality of oblique warp and weft yarns, and is connected at upper and lower points to either side to the inflatable regions. The connection points are closer to each other prior to inflation of the air bag (figure 2), the air bag being such that, as the inflatable regions inflate, the respective connection points move apart (figure 3) causing the relative inclination of the warp and weft yarns to alter thus reducing the width (D) of the woven element. This reduction in width applies tension to the air bag.



**FIG. 1**



FIG 2

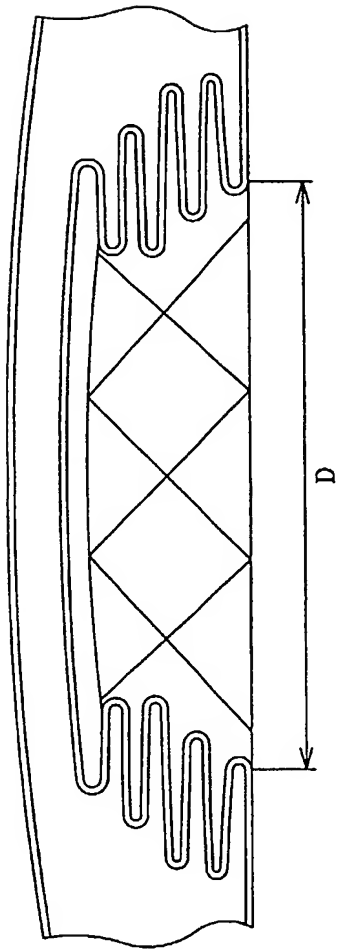
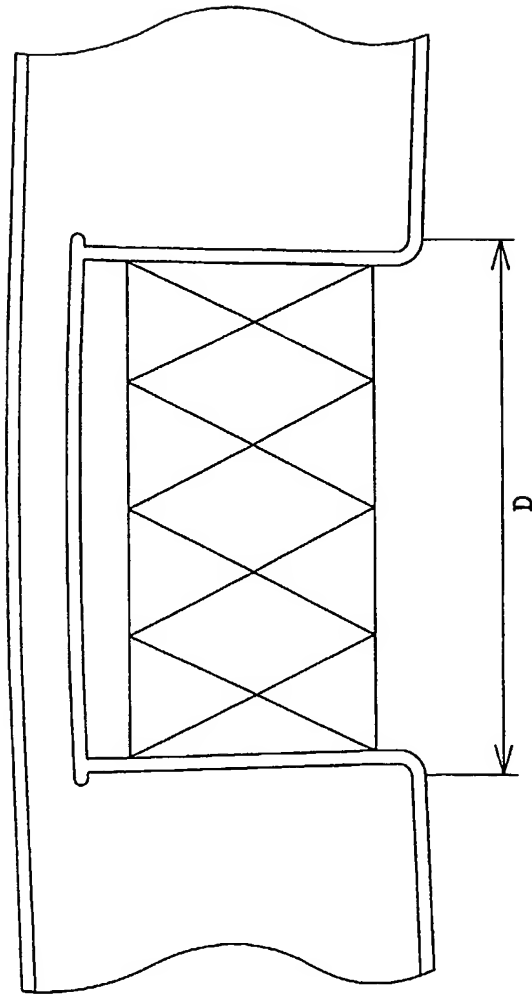


FIG 3



PATENTS ACT 1977

PI4950GB-NF/ARL/v1

**“Improvements in or relating to an air-bag arrangement”**

THE PRESENT INVENTION relates to an air-bag arrangement and more particularly relates to an air-bag arrangement in a motor vehicle such as a car.

It has been proposed to provide an air-bag arrangement in the form of an inflatable curtain which, when inflated, is located between the head, and upper torso, of an occupant of the vehicle and the side of the vehicle. Such an inflatable curtain is initially stored in an uninflated condition in a housing or recess in the roof frame of the vehicle and, when inflated, extends from the roof of the vehicle to a position adjacent the side windows. The inflated bag may extend past the B pillar of the vehicle and possibly also the A and C pillars. The purpose of such an air-bag is to prevent the head of an occupant of the vehicle hitting a window or a pillar of the vehicle and also to prevent the head of the occupant from emerging through the window opening if, in an accident situation, the window should be broken, or in a lowered position.

It is important that during a side impact, the air-bag has sufficient rigidity and, in particular, a region of the air-bag is sufficiently taut such that the air-bag is not forced out of a broken or open window.

The present invention seeks to provide an improved air-bag arrangement in which the air-bag may be deployed swiftly using a small amount of gas, with

a predetermined region of the air-bag being substantially taut when the bag is inflated.

According to the present invention there is provided an air-bag adapted to be mounted in an elongate, non-straight recess in the roof of a motor vehicle, the air-bag arrangement comprising at least two inflatable regions and a woven interconnecting element, an upper edge of the air-bag having anchoring means to be secured to the recess, each inflatable region being such that on inflation of the air-bag it is located beneath the said upper edge with the inflatable regions being spaced-apart from one another, an outer side edge of at least one said region being provided with anchoring means to be connected to a respective anchoring point on the vehicle, the woven interconnecting element comprising a plurality of interwoven warp yarns and weft yarns and being on the bias, said woven element being connected at one end thereof to at least a first point on a substantially vertical inner edge of the first inflatable region spaced a predetermined distance from the upper edge and to at least a second point spaced further from the upper edge on the said substantially vertical inner edge, the woven element also being secured at an opposing end to equivalent first and second points on a substantially vertical inner edge of the second inflatable region, the said respective first and second points being close to each other prior to inflation of the air-bag, the air-bag being such that, as the inflatable regions inflate, the respective first and second points move apart causing the relative inclination of the warp and weft yarns to alter thus reducing the width of the woven element.

Preferably the woven interconnecting element is formed integrally with inflatable regions.

Alternatively the woven interconnecting element is formed separately from the inflatable regions and is subsequently secured to each inflatable region.

Conveniently the woven interconnecting element is secured using adhesive.

Conveniently the inflatable regions and the interconnecting elements have a coating applied to them.

Alternatively a coating is only applied to the inflatable regions.

Preferably the coating is substantially silicon based.

Conveniently each inflatable region comprises a plurality of parallel cells, each cell being in communication with part of a gas duct to supply as thereto.

Advantageously the axes of the cells intersect a line between two spaced-apart anchoring means.

Preferably the woven element comprises a strip of fabric having relatively widely spaced interwoven weft yarns such as the strip of fabric has a net-like structure.

In order that the invention may be more readily understood and so that further features thereof may be appreciated, the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIGURE 1 is a sectional side view of an air-bag arrangement of the current invention with a plurality of inflatable cells, each in a substantially inflated condition;

FIGURE 2 is an enlarged sectional side view of part of the air-bag arrangement of Figure 1 shortly after inflation of the air-bag has commenced; and

FIGURE 3 is an enlarged sectional side view corresponding to Figure 2, but when the air-bag is fully inflated.

Referring initially to Figure 1, the air-bag arrangement includes an air-bag 1 which is an inflatable curtain. The air-bag 1 is formed from two superimposed layers of fabric, selected areas of which are secured together to define a gas duct 2 (which is connected to a gas generator 3) a first substantially rectangular, inflatable region 4, a second substantially rectangular, inflatable region 5 which is spaced from the region 4 and a woven interconnecting element 6.

The gas duct 2 is substantially elongate and has one end connected to receive gas from the gas generator 3. The gas duct 2 extends across the upper edge of the air-bag 1 and is provided with anchoring means in the form of spaced-apart mounting tabs 7, each of which is apertured to enable the upper edge of the air-bag to be secured to a motor vehicle.

The first inflatable region 4 is located beneath the end of the gas duct 2 remote from the gas generator 3 and the second inflatable region 5 is located beneath the end of the gas duct 2 adjacent the gas generator 3. The inflatable

regions are connected to the gas duct to receive gas from the gas duct. The inflatable regions 4 and 5 are spaced-apart so that there is a gap between the regions 4 and 5 beneath the gas duct 2.

In the inflatable region 4 the superimposed layers of fabric are interconnected to define a plurality of parallel, substantially vertical cells 8. The upper part of each cell 8 communicates by means of an opening 9, with the gas duct 2, so that gas flowing through the gas duct 2 will inflate the cells 8. The inflatable region 5 similarly comprises a plurality of substantially parallel vertical cells 8 which communicate with the gas duct.

The air-bag 1 is configured so that, on actuation of the gas generator 3, gas flows from the gas generator 3, along the gas duct 2 and into the cells 8 such that the cells 8 inflate the inflatable regions 4 and 5. The regions 4 and 5 will inflate and extend substantially perpendicularly to the axis of the gas duct 2.

An outer edge 10 of the first inflatable region 4 is provided with an anchoring strap 11, which is connected to that part of the edge which is furthestmost from the gas duct 2 on inflation of the air-bag 1. The anchoring strap 11 is provided with anchoring means in the form of a fixing eye such that the anchoring strap 11 may be secured to an anchoring point of the vehicle. The second inflatable region 5 is provided with anchoring means in the form of a corresponding anchoring strap 12 on its outer edge and the strap 12 is provided with anchoring means in the form of a fixing eye such that the anchoring strap 12 may be secured to another anchoring point on the vehicle. The straps 11, 12 each serve to connect an outer side edge of the a respective inflatable region to an anchoring point on the vehicle.



An inner edge 13 of the first inflatable region 4 and an inner edge 14 of the second inflatable region 5 are interconnected by the woven interconnecting element 6. The woven interconnecting element 6 comprises a woven sheet comprising a plurality of interwoven warp and weft yarns 15 and 16 respectively. The woven interconnecting element 6 could comprise a relatively close weave fabric having a relatively high number of interwoven warp and weft yarns. However, the woven interconnecting element 6 preferably comprises relatively few interwoven warp and weft yarns such that the woven interconnecting element 6 has a net like or lattice structure. The woven interconnecting element 6 is formed or cut on the bias. Thus, each edge extends obliquely across the weave of the fabric, so that the warp and weft yarns, when the fabric is laid out flat, are not parallel with the edges of the element 6.

One end of the woven interconnecting element 6 is secured to inner edge 13 of the first inflatable region 4. It is to be appreciated that spaced-apart points on said one end of the woven interconnecting element 6 are secured to corresponding spaced apart points on the inner edge 13 of the inflatable region 4 such as a point adjacent the gas duct 2 and a second part of the inner edge 13 spaced further away from the gas duct 2. The vertically spaced-apart points may be the upper edge and the lower edge of the interconnecting element. Vertically spaced-apart points on the other end of the woven interconnecting element 6 are similarly secured to inner edge 14 of the second inflatable region 5.

It is to be further appreciated that, when the air-bag is inflated, the warp yarns and/or the weft yarns 15 and 16 are orientated at an angle of less than 90 degrees to the substantially vertical inner edges 12 and 13 of the inflatable regions 4 and 5 respectively. Preferably both warp and weft yarns are so orientated and in most preferred embodiments the warp yarns 15 and the weft

yarns 16 are each orientated at an angle of between 33 and 45 degrees to the substantially vertical inner edges 12 and 13 of the inflatable regions 4 and 5 respectively.

The woven interconnecting element 6 may be formed as a separate sheet of fabric to the fabric of the inflatable regions 4 and 5. The woven interconnecting element 6 would then be secured to the inflatable regions 4 and 5 using adhesive or by stitching along the inner edges 13 and 14 of the inflatable regions 4 and 5 respectively.

If the woven interconnecting element 6 comprises a separate sheet of fabric, while the inflatable regions may be coated, as is well known in the art, with a coating to ensure each region 4 and 5 was gas tight, the woven interconnecting element 6 would not be coated. It is to be appreciated that an un-coated woven interconnecting element 6 will function in the manner described below more effectively than a coated woven interconnecting element 6.

Alternatively, the woven interconnecting element 6 and the inflatable regions 4 and 5 may be formed of the same sheet of fabric in which case the woven interconnecting element 6 would be formed integrally with the inflatable regions 4 and 5 in the position described above. In a preferred embodiment of this type, only the inflatable regions would be coated with the gas tight coating. Thus, if a single piece of fabric was used, the inflatable regions 4 and 5 could be coated using a coating device having two coating heads, using one respective coating head for each inflatable region. Alternatively, a removable masking sheet could be positioned, during the coating process, adjacent the woven element 6 so that none of the woven interconnecting element 6 was exposed to the coating material. A single coating head could then be used to coat both

inflatable regions 4 and 5 and the removable masking sheet. After the coating process, the removable masking sheet could be separated from the woven interconnecting element 6 such that the inflatable regions 4 and 5 would have the required gas tight coating whilst the woven interconnecting element 6 was un-coated.

However, it is to be appreciated that, if a coating having a high degree of elongation such as a silicone based coating was used, the woven interconnecting element 6 and the inflatable regions 4 and 5 could all be coated.

When in an un-inflated condition the inflatable regions 4 and 5, the gas duct 2 and the woven interconnecting element 6 may be folded such that the folded elements may be introduced into a covering sleeve or housing. The mounting tabs 7 will project from the sleeve or housing. The sleeve or housing may be mounted in a recess in the roof of the motor vehicle with the tabs 7 being engaged with hooks or clips provided in the recess for that purpose.

The recess is located above the door opening or opening in the vehicle and follows the curve of the roof and is thus not straight. The recess typically extends down at least one of the A and C pillars of the vehicle and extends across the top of the B pillar. The straps 11 and 12 are secured to anchoring points at opposite ends of the recess.

Before the air-bag is inflated, the air-bag 1 and the straps 11 and 12 are present in the recess, with the tabs 7 connected to the hooks or clips located above the door opening and the straps 11 and 12 secured to anchoring points at the ends of the recess, and thus the entire element has a non-straight configuration. The inflatable regions 4 and 5 are in a collapsed condition and

thus the first and second parts of the inner edge 13 of the inflatable region 4 (and also the corresponding parts of the inner edge 14 of the inflatable region 4) are relatively close together and thus the upper and lower edges of the woven interconnecting element 6 are relatively close together where the element 6 is connected to the inflatable region 4. The warp and weft yarns 15 and 16 of the interconnecting element 6 may then be positioned to be substantially parallel, or as close to substantially parallel as possible, with the warp and weft yarns crossing at an acute angle so that the connecting element 6 has a relatively long length. The interconnecting element 6 thus has an effective length D as shown in Figure 2. This facilitates the storage of the uninflated air-bag in the recess.

In an accident situation, the gas from the gas generator 3 flows along the gas duct 2 and through the apertures 9 into the cells 8 such that the inflatable regions 4 and 5 inflate. As they inflate, the regions 4 and 5 extend substantially perpendicularly to the gas duct 2 such that the inflatable regions 4 and 5 emerge from the housing into a position between the occupants of the vehicle and the doors and windows at the side of the vehicle.

On entering the cells 8, the gas causes the fabric forming the opposed side walls of the cells 8 to bulge outwardly as the cells assume a cylindrical form and thus the width of each inflatable region 4 and 5 decreases.

As each inflatable region 4 and 5 inflates, the woven interconnecting element 6 will extend in the vertical direction substantially perpendicularly to the gas duct 2. It is to be appreciated that, as the woven interconnecting element 6 is moved to the position in which it extends vertically, the ends of the element which are attached to the inner edges of each inflatable region 4 and 5 will move such that the actual distance between the points at which the

interconnecting element is secured to the inflatable regions 4, 5, increases. This increase between the interconnecting points will apply a force tending to increase the distance between the yarns, and because of the net-like or lattice structure of the fabric, the relative inclination of the warp and weft yarns alters, reducing the acuteness of the angle of intersection between the warp and weft yarns. This alteration of the relative inclination of the yarns effectively contracts the interconnecting woven element in a substantially horizontal direction such that the effective length D of the woven element 6 is reduced. It is to be appreciated that this reduction of the effective length D of the woven element 6 together with the decrease of width of the inflatable regions 4, 5, caused by the inflating cells 8, applies a line of considerable tension along the lower edge of the air-bag 1 between the anchoring straps 11 and 12. The line of tension extends between the two anchoring points that are spaced-apart along the non-straight recess, and the axes of the cells 8 intersect the line of tension.

Thus, in an accident situation, the line of considerable tension will help ensure the inflatable regions 4 and 5 remain inside the vehicle to provide suitable protection to the head and upper torso of the occupant of the vehicle.

In the present specification "comprise" means "includes or consists of" and "comprising" means "including or consisting of".

The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

CLAIMS:

1. An air-bag adapted to be mounted in an elongate, non-straight recess in the roof of a motor vehicle, the air-bag arrangement comprising at least two inflatable regions and a woven interconnecting element, an upper edge of the air-bag having anchoring means to be secured to the recess, each inflatable region being such that on inflation of the air-bag it is located beneath the said upper edge with the inflatable regions being spaced-apart from one another, an outer side edge of at least one said region being provided with anchoring means to be connected to a respective anchoring point on the vehicle, the woven interconnecting element comprising a plurality of interwoven warp yarns and weft yarns and being on the bias, said woven element being connected at one end thereof to at least a first point on a substantially vertical inner edge of the first inflatable region spaced a predetermined distance from the upper edge and to at least a second point spaced further from the upper edge on the said substantially vertical inner edge, the woven element also being secured at an opposing end to equivalent first and second points on a substantially vertical inner edge of the second inflatable region, the said respective first and second points being close to each other prior to inflation of the air-bag, the air-bag being such that, as the inflatable regions inflate, the respective first and second points move apart causing the relative inclination of the warp and weft yarns to alter thus reducing the width of the woven element.

2. The air-bag of Claim 1 wherein the woven interconnecting element is formed integrally with the inflatable regions.

3. The air-bag of Claim 1 wherein the woven interconnecting element is formed separately from the inflatable regions and is subsequently secured to each inflatable region.

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4. The air-bag of Claim 3 wherein the woven interconnecting element is secured using adhesive.
5. The air-bag of any one of the preceding Claims wherein the inflatable regions and the interconnecting woven element have a coating applied to them.
6. The air-bag of any one of Claims 1 to 4 wherein a coating is only applied to the inflatable regions.
7. The air-bag of any-one of Claims 5 or 6 wherein the coating is substantially silicon based.
8. The air-bag of any one of the preceding claims wherein each inflatable region comprises a plurality of parallel cells, each cell being in communication with part of a gas duct to supply gas thereto.
9. The air-bag of Claim 8 wherein the axes of the cells intersect a line between two spaced-apart anchoring means.
10. The air-bag of any one of the preceding Claims wherein the woven element comprises a strip of fabric having relatively widely spaced interwoven warp and weft yarns such that the strip of fabric has a net like structure.
11. The air-bag of any one of the preceding claims mounted in an elongate non-linear recess of a motor vehicle.
12. An air-bag substantially as herein described with reference to and as shown in the accompanying drawings.

13. Any novel feature or combination of features disclosed herein.





INVESTOR IN PEOPLE

**Application No:** GB 0108715.4  
**Claims searched:** 1 to 11

**Examiner:** Peter Gardiner  
**Date of search:** 1 August 2001

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.S): B7B: BSBCC, BSBCR

Int CI (Ed.7): B60R: 21/16, 21/20

Other: Online: WPI, EPODOC, JAPIO

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	WO 00/07854 A1 DELPHI TECHNOLOGIES (see whole document)	
A	WO 99/62746 A1 BREED AUTOMOTIVE TECHNOLOGY (see webbing portion 20 separating inflatable elements)	
A	US 5322322 SIMULA (see figures 4a and 4b in particular)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.